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JANUARY 1988

REPORT NO. EVT 41-87

MIL-STD-1660 TESTS OF 155MM PLASTIC CONTAINERS FOR PROPELLING CHARGE

Prepared for:
Office of the Project Manager,
Ammunition Logistics
ATTN: AMCPM-AL
Picatinny Arsenal, NJ 07806-5000

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The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by the Office of the Project Manager, Ammunition Logistics (PM-AMMOLOG) to develop and test a pallet for 155MM plastic containers for propelling charge. Due to the compressible nature of the containers, the pallet had to be designed as a "box" of a fixed height for the units to be stackable. Three different modifications were required before a satisfactory unit was tested. The 155MM plastic containers for propelling charge are not very well designed in terms of layer-to-layer interlocking. This was reflected when the unit was edgewise rotationally dropped and the whole layer separated from the unit. By rotating the containers 90 degrees and reducing the height of the "box braces," a suitable unit was achieved. The container pallet as tested successfully passed MIL-STD-1660, Design Criteria for Ammunition Unit Loads, tests; however, design changes are necessary to correct container interlocking deficiencies.

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REPORT NO. EVT 41-87

MIL-STD-1660 TESTS OF 155MM PLASTIC CONTAINERS FOR PROPELLING CHARGE

JANUARY 1988

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PART 1

INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by the Office of the Project Manager, Ammunition Logistics (PM-AMMOLOG) to develop and test a pallet for 155MM plastic containers for propelling charge. Due to the compressible nature of the containers, the pallet had to be designed as a "box" of a fixed height for the units to be stackable. Three different modifications were required before a satisfactory unit was tested. The 155MM plastic containers for propelling charge are not very well designed in terms of layer-to-layer interlocking. This was reflected when the unit was edgewise rotationally dropped and the whole layer separated from the unit. By rotating the containers 90 degrees and reducing the height of the "box braces," a suitable unit was achieved.

B. AUTHORITY. This test was conducted IAW mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Rock Island, IL. Reference is made to AR-700, 15 April 1979; DARCOM Supplement 1, 4 September 1979; and AMCCOM-R 10-17, 13 January 1986, Mission and Major Functions of USADACS.

C. OBJECTIVE. The objective of this test was to determine if the 155MM plastic container for propelling charge pallet satisfied the testing requirements of MIL-STD-1660, Design Criteria for Ammunition Unit Loads.

D. CONCLUSION. The 155MM plastic propelling charge containers have two different types of container interlocks. One is a "hook" style that is intended for side-to-side positioning of the container. The hooks present a positive lock between containers. The other style of interlock is a tapered "peg," intended for interlocking layers of containers. The layer interlocks were not

effective in holding the containers on the pallet. The hook interlocks were effective, but interfered with the banding on the side of the pallet..

E. RECOMMENDATION. It is recommended that the 155MM plastic containers for propelling charge be rotated 90 degrees on the pallet such that the "hook" interlock is aimed upward and the "peg" interlocks are oriented toward the side of the pallet. With this position change, the plastic containers remain on the pallet and within the stack through the MIL-STD-1660 testing cycle.

In future designs of plastic interlocking containers, thought must be given to the interlock design to accommodate horizontal shear impact forces as well as ease of constructing the pallet.

PART 2

30 JULY 1987; 14-15 SEPTEMBER 1987; AND 21 JANUARY 1988

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PART 3

TEST PROCEDURES

The test procedures outlined in this section are extracted from MIL-STD-1660, Design Criteria for Ammunition Unit Loads, 8 April 1977. This standard identifies nine steps that a unitized load must undergo if it is considered to be acceptable. The five tests that were conducted are synopsized below.

A. STACKING TESTS. The unit load was loaded to simulate a stack of identical unit loads stacked 16 feet high, for a period of one hour. This stacking load was simulated by subjecting the unit load to a compression of weight equal to an equivalent 16-foot stacking height. The compression load was calculated in the following manner. The unit load weight is divided by the unit load height in inches and multiplied by 192. The resulting number is the equivalent compressive force of a 16-foot-high load.

B. REPETITIVE SHOCK TEST. The repetitive shock test was conducted IAW Method 5019, Federal Standard 101. The test procedure was as follows: The test specimen was placed on, but not fastened to, the platform. With the specimen in one position, the platform was vibrated at 1/2-inch amplitude (1-inch double amplitude) starting at a frequency of about 3 cycles-per-second. The frequency was steadily increased until the package left the platform. The resonant frequency was achieved when a 1/16-inch-thick feeler could be momentarily slid freely between every point on the specimen in contact with the platform at some instance during the cycle or when a platform acceleration achieved 1 $\pm$ 0.1 G. Midway into the testing period, the specimen was rotated 90 degrees and the test continued for the duration. If failure occurs, the total time of vibration is two hours if the specimen is tested in one position; and, if tested in more than one position, the total time is three hours.

C. EDGEWISE DROP TEST. This test was conducted by using the procedures of Method 5008, Federal Standard 101. The procedure for the Edgewise Rotational Drop Test was as follows: The specimen was placed on its bottom with one end of the base of the container supported on a sill, nominally six inches high. The height of the sill was increased, if necessary, to ensure that there would be no support for the base between the ends of the container when dropping took place, but was not high enough to cause the container to slide on the supports when the dropped end was raised for the drops. The unsupported end of the container was then raised and allowed to fall freely to the concrete, pavement, or similar underlying surface from a prescribed height. Unless otherwise specified, the height of drop for level A protection shall conform to the following tabulation.

GROSS WEIGHT NOT EXCEEDING Pounds	DIMENSIONS ON ANY EDGE NOT EXCEEDING Inches	HEIGHT OF DROP LEVEL A PROTECTION Inches
600	72	36
3,000	no limit	24
no limit	no limit	12

D. IMPACT TEST. This test was conducted by using the procedure of Method 5023, Incline-Impact Test of Federal Standard 101. The procedure for the Incline-Impact Test was as follows: The specimen was placed on the carriage with the surface or edge which was impacted projecting at least two inches beyond the front end of the carriage. The carriage was brought to a predetermined position on the incline and released. If it is desired to concentrate the impact on any particular position on the container, a 4- by 4-inch timber may be attached to the bumper in the desired position before the test. No part of the timber was struck by the carriage. The position of the container on the carriage and the sequence in which surfaces and edges were subjected to impacts may be at the option of the testing activity and will depend upon the

objective of the tests. When the test is to determine satisfactory requirements for a container or pack, and, unless otherwise specified, the specimen shall be subjected to one impact on each surface that has each dimension less than 9.5 feet. Unless otherwise specified, the velocity at time of impact was 7 feet-per-second.

E. SLING COMPATIBILITY TEST. Unit loads utilizing special design for nonstandard pallets were lifted, slung, lowered, and otherwise handled as necessary using slings of the types normally used for handling the unit loads under consideration. Slings shall be easily attached and removed. Danger of slippage or disengagement when the load is suspended is cause for rejection of the unit load.

PART 4

TEST RESULTS

A. Date of Test - 30 July 1987.

B. Stacking Test.

1.	Pallet width	35 inches
2.	Length	45
3.	Height	52
4.	Weight	1,700 pounds
5.	Test Load Weight	6,400 pounds

C. Transportation Simulator - Repetitive Shock Test.

1. Longitudinal orientation.
   (a) Operational speed 160 rpm
   (b) Containers move independently within box frame.
2. Lateral Orientation.
   (a) Operational speed 150 rpm
   (b) Containers move independently in frame.

D. Edgewise Rotational Drop - Drop Height 24 inches.

1. Side 1 - no damage.
2. Side 2 - no damage.
3. Side 3 - no damage.
4. Side 4 - The plastic containers compressd when loaded, which resulted in a lower overall stacking height than when empty. This allowed the containers to move about in the pallet box. On the last rotational drop, the whole pallet rolled over. When it was uprighted, containers from the second row up came out of the stack. This movement was supposed to be restrained by the top and bottom interlocks. These interlocking points have an angled surface which, coupled with the deformable case, permits "ramping" out of the interlock. Corrective

actions are as follows: 1) Add bundling straps - four up and four down. 2) Add more vertical pallet support to catch container interlocks.

E. Slinging Test.

1. Four sling legs. ok.
2. Three sling legs. ok.
3. Two diagonal legs. ok.
4. Two lateral legs. ok.
5. Single sling leg. ok.

Testing was suspended after the slinging test because the containers failed to stay inside the pallet.

TEST RESULTS

A. Dates of Test - 14-15 September 1987.

B. Transportation Simulator - Repetitive Shock Test.

1. Longitudinal orientation.
    (a) Operational speed 180 rpm
    (b) Containers move independently within box frame.
2. Lateral Orientation.
    (a) Operational speed 180 rpm
    (b) Containers move independently in frame and cut into vertical supports.

C. Edgewise Rotational Drop - Drop Height 24 inches.

1. Side 1 - unit pack shifted out and returned.
2. Side 2 - no damage.
3. Side 3 - weight load shifted in containers, changing the center of gravity.
4. Side 4 - no damage.

D. Incline-Impact. Using shear plates at the top and bottom of pallet.

1. Side 1 - no bundling straps. Failed.
2. Side 1 - bundling straps. Failed.

TEST RESULTS

A. Date of Test - 21 January 1988.

B. Stacking Test.

1. Pallet width	35 inches
2. Length	45
3. Height	52
4. Weight	1,890 pounds
5. Test Load Weight	7,115 pounds

C. Transportation Simulator - Repetitive Shock Test.

1. Longitudinal orientation.
   - (a) Operational speed 190 rpm
   - (b) Containers move within box frame.
2. Lateral Orientation
   - (a) Operational speed 190 rpm
   - (b) Containers move in frame.

D. Edgewise Rotational Drop - Drop Height 24 inches.

1. Side 1 - no damage.
2. Side 2 - no damage.
3. Side 3 - no damage.
4. Side 4 - no damage.

E. Slinging Test.

1. Four sling legs.	ok.
2. Three sling legs.	ok.
3. Two diagonal legs	ok.
4. Two lateral legs.	ok.
5. Single sling leg.	ok.

F. <u>Incline-Impact</u> - incline stop position no. 7.

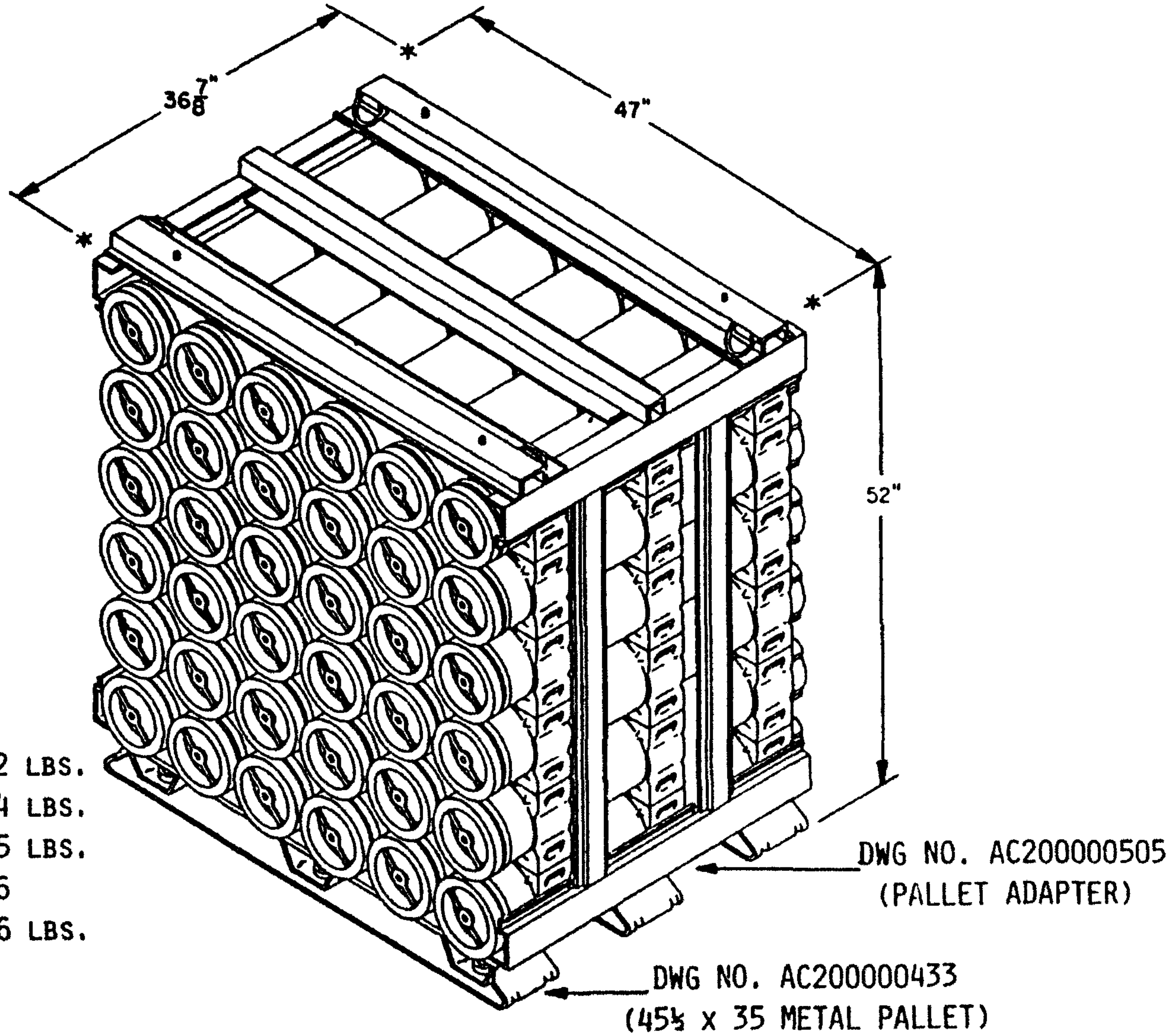
1. Side 1.	ok.
2. Side 2.	ok.
3. Side 3.	ok.
4. Side 4.	ok.

155MM plastic containers for propelling charge were oriented on the modified pallet so that the interlocking "hooks" pointed upward. The "protuding" hooks were accommodated by modifications in the pallet top adapter to use them as positive movement stops.

PART 5

DRAWING

155 MM PLASTIC CONTAINERS FOR PROPELLING CHARGE



(ESTIMATES)	
PALLET WT.	82 LBS.
ADAPTER WT.	84 LBS.
UNIT PACK WT.	45 LBS.
UNIT PACK/PALLET	36
UNiT PACK/WT.	1,786 LBS.

MAY 1987

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PART 6

PHOTOGRAPHS

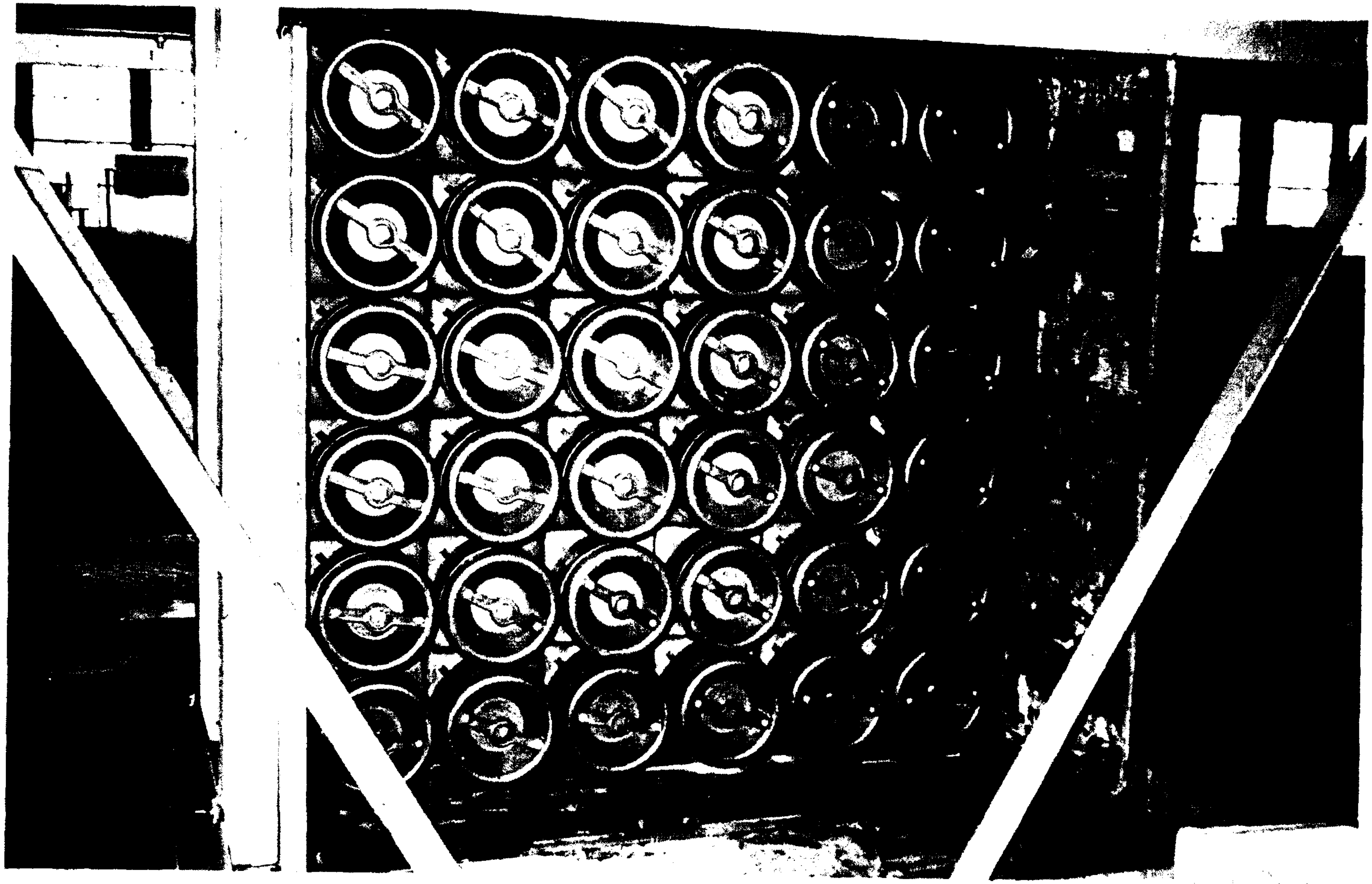

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Photo No. EVT87-41-001. This photo shows the 155MM plastic pallet containers for propelling charge positioned longitudinally on the transportation simulator (repetitive shock test). The plastic containers moved independently inside the pallet.

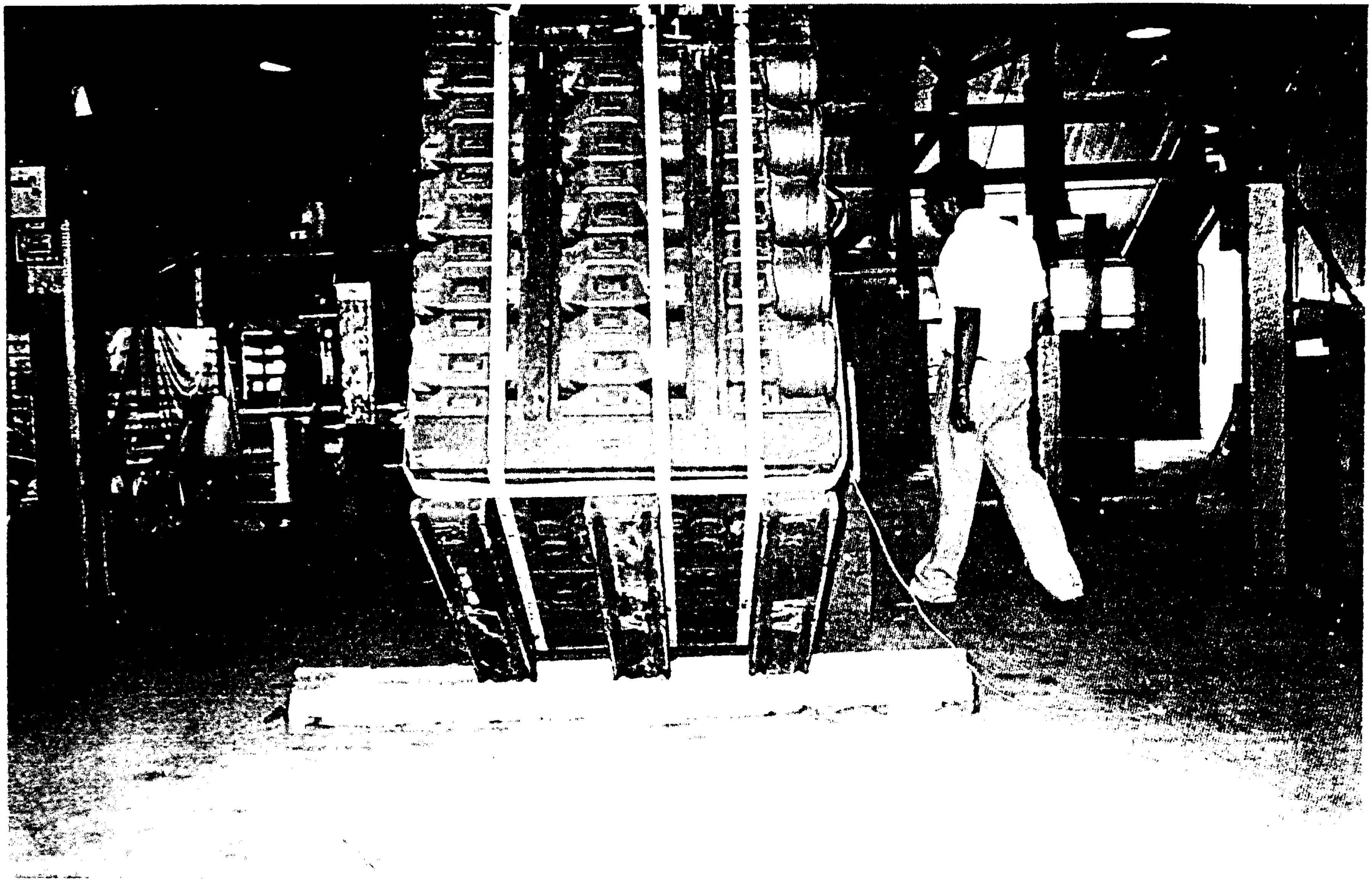

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Photo No. EVT87-41-005. This photo shows the pallet positioned for the first edgewise rotational drop test.

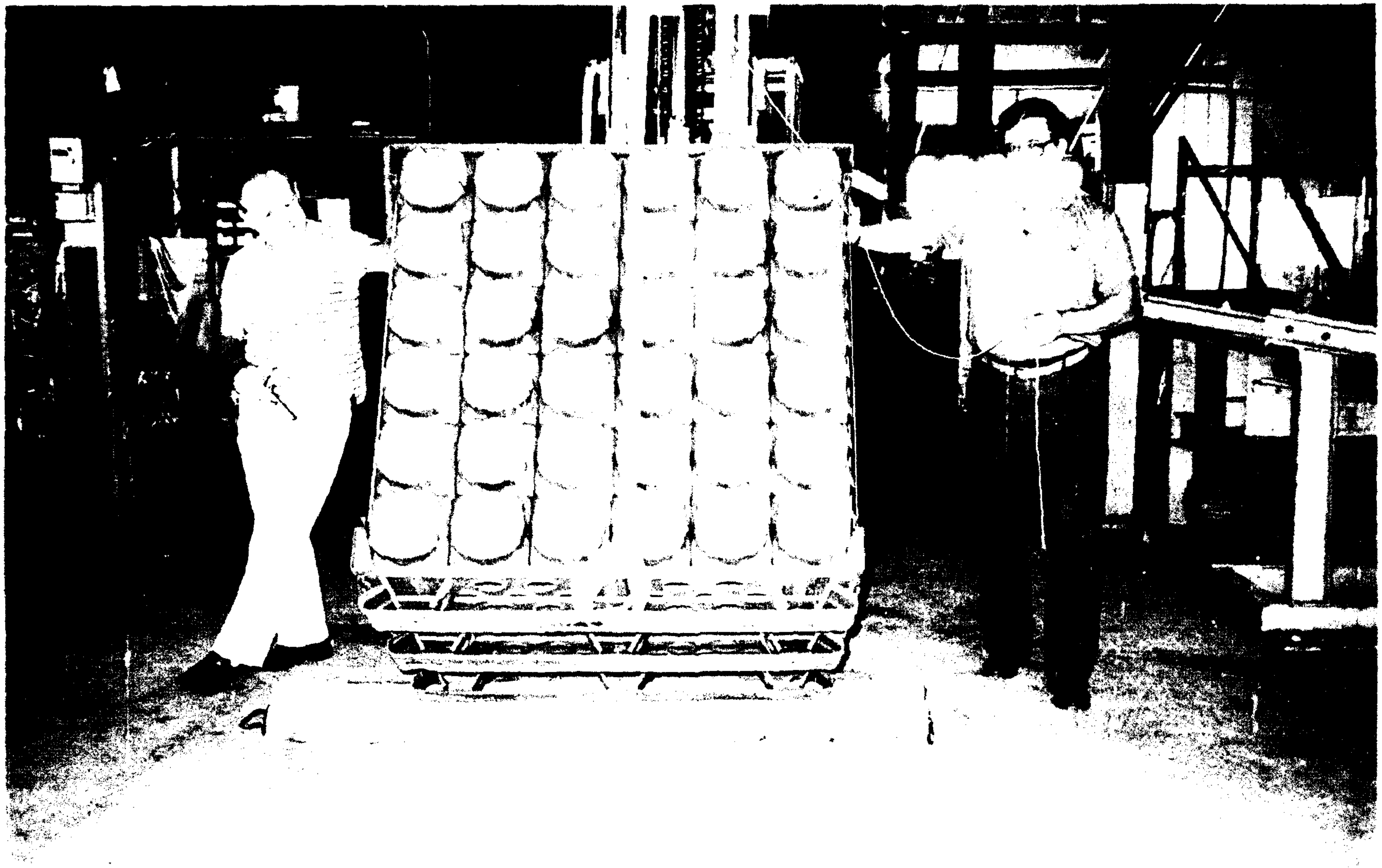

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Photo No. EVT87-41-006. This photo shows the 155MM plastic pallet containers for propelling charge positioned for the second edgewise rotational drop test.

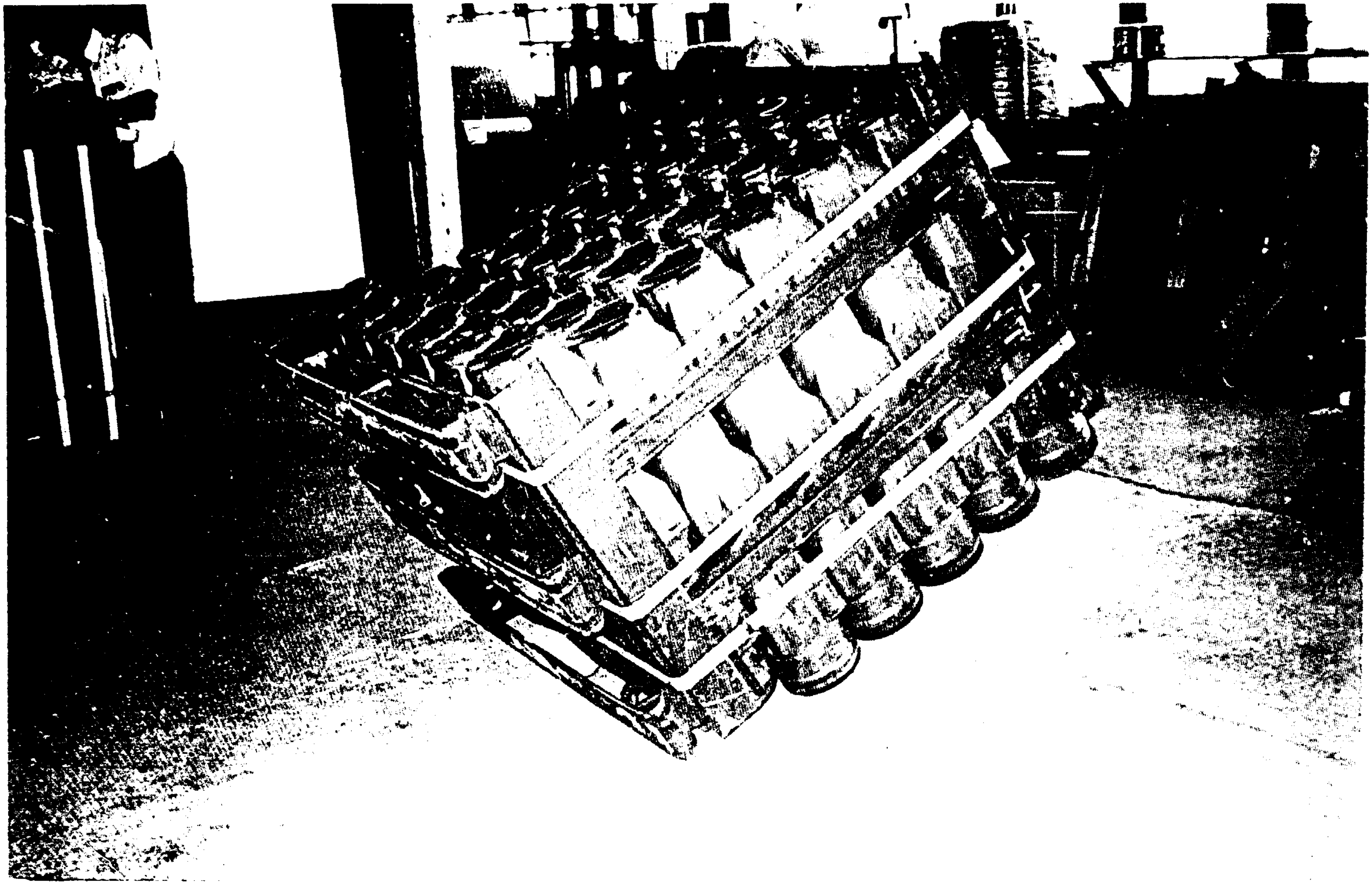

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Photo No. EVT87-41-012. This photo shows the 155MM plastic pallet containers for propelling charge after rolling over from the fourth and last edgewise rotational drop test. Note the layers of containers protruding from the pallet. The horizontal interlocks failed to remain engaged when the pallet was being uprighted.

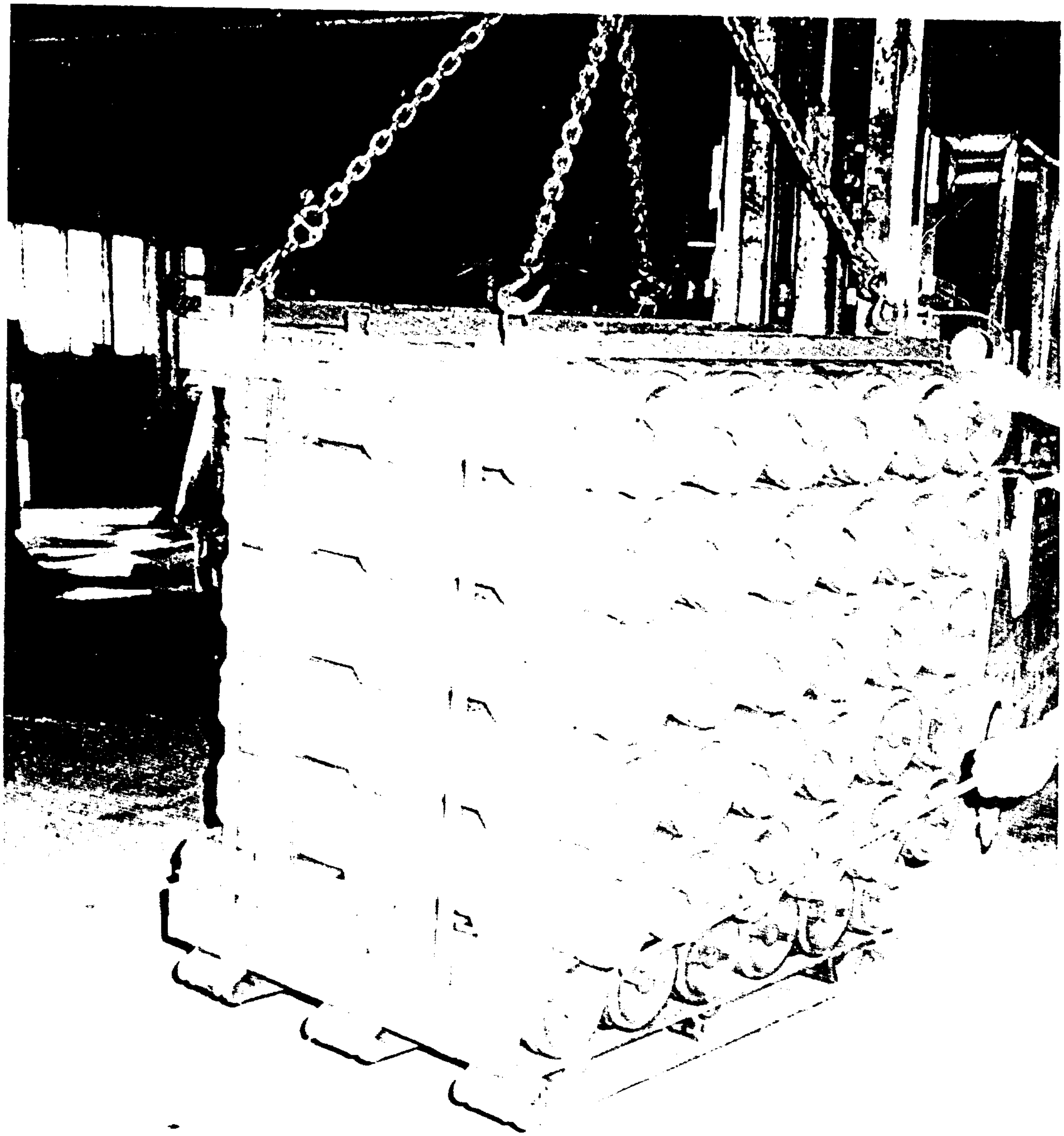

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Photo No. EVT87-41-014. This photo shows the 155MM plastic pallet containers for propelling charge ready for lifting with four slinging legs. Note containers sticking out of pallet.		

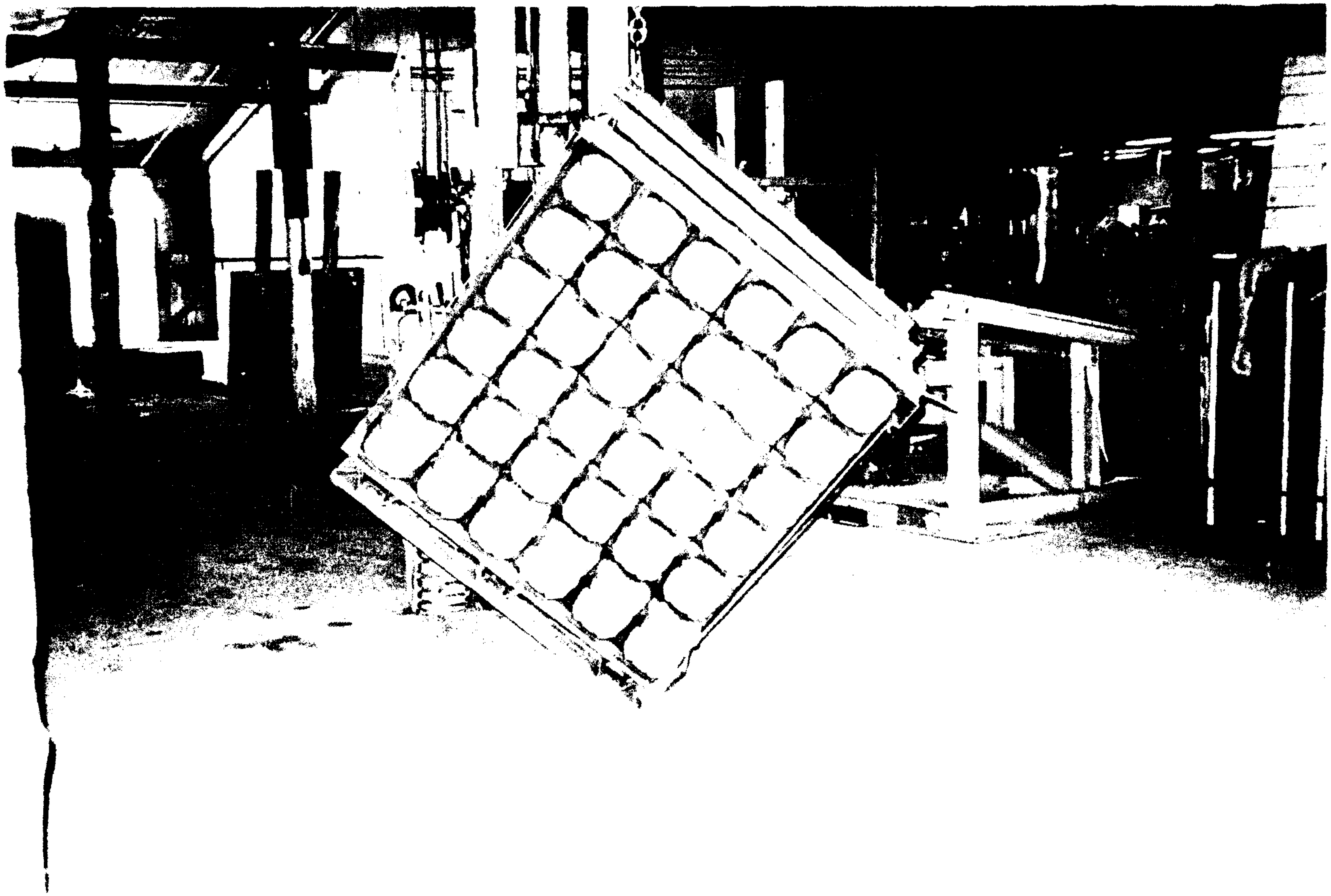

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Photo No. EVT87-41-019. This photo shows the 155MM plastic pallet containers for propelling charge being lifted from one sling point.

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Photo No. EVT87-41-020. This photo shows the 155MM plastic pallet containers for propelling charge after moving the rear upright toward the rear of the unit. This was thought to be a fix to hold the containers on the pallet during incline-impact tests.

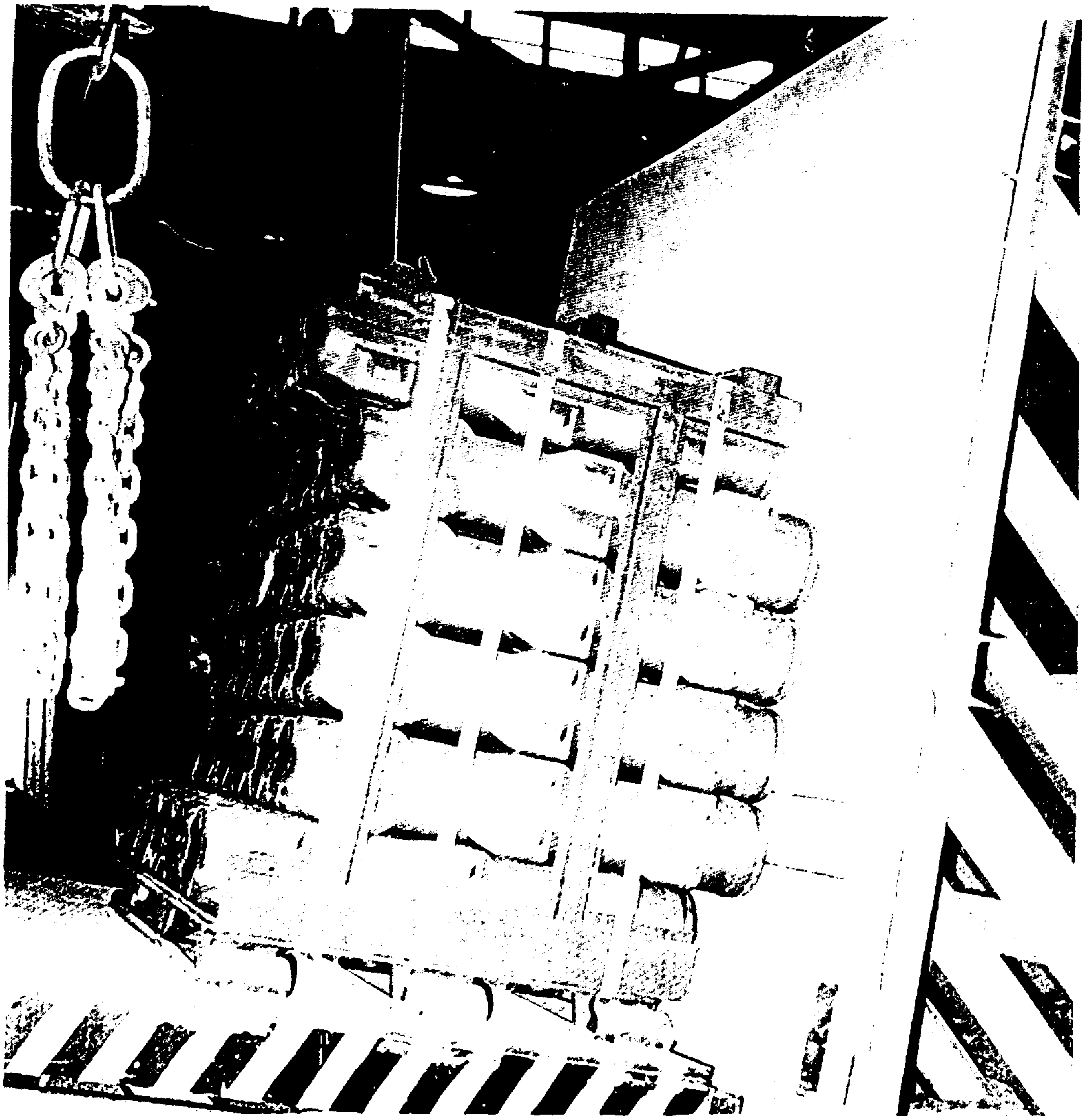

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Photo No. EVT87-41-025. This photo shows the modified pallet after an incline-impact. Note that the pallet modifications did not retain the 155MM plastic pallet containers for propelling charge nested on the pallet.

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Photo No. EVT87-41-027. This photo shows the modified pallet after an incline-impact. Bundling straps have been added to the load to assist in restraining the 155MM plastic pallet containers for propelling charge movement. This photo shows that the pallet modifications and bundling straps do not effectively keep the unit together.

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Photo No. EVT87-41-031. This is a closeup of the upper layer of 155MM plastic pallet containers for propelling charge and the pallet top adapter. Note the space between the top layer and adapter.